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10 CFR 50.73

APR 06 2016

Serial: BSEP 16-0021

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Brunswick Steam Electric Plant, Unit No. 1
Renewed Facility Operating License No. DPR-71
Docket No. 50-325
Licensee Event Report 1-2016-001

In accordance with the Code of Federal Regulations, Title 10, Part 50.73, Duke Energy Progress, Inc., submits the enclosed Licensee Event Report (LER). This report fulfills the requirement of 10 CFR 50.73(a)(1) for a written report within sixty (60) days of a reportable occurrence.

Please refer any questions regarding this submittal to Mr. Lee Grzeck, Manager – Regulatory Affairs, at (910) 457-2487.

Sincerely,

A handwritten signature in black ink, appearing to read 'WRG', written over a horizontal line.

William R. Gideon

SWR/swr

Enclosure: Licensee Event Report 1-2016-001

IE22
NRR

cc (with enclosure):

U. S. Nuclear Regulatory Commission, Region II
ATTN: Ms. Catherine Haney, Regional Administrator
245 Peachtree Center Ave, NE, Suite 1200
Atlanta, GA 30303-1257

U. S. Nuclear Regulatory Commission
ATTN: Ms. Michelle P. Catts, NRC Senior Resident Inspector
8470 River Road
Southport, NC 28461-8869

U. S. Nuclear Regulatory Commission
ATTN: Mr. Andrew Hon (Mail Stop OWFN 8G9A) **(Electronic Copy Only)**
11555 Rockville Pike
Rockville, MD 20852-2738

Chair - North Carolina Utilities Commission
P.O. Box 29510
Raleigh, NC 27626-0510

**LICENSEE EVENT REPORT (LER)**(See Page 2 for required number of
digits/characters for each block)

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to Infocollections.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOF-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME

Brunswick Steam Electric Plant (BSEP) Unit 1

2. DOCKET NUMBER

05000325

3. PAGE

1 OF 5

4. TITLE

Electrical Bus Fault Results in Lockout of Startup Auxiliary Transformer and Loss of Offsite Power

5. EVENT DATE

MONTH	DAY	YEAR
02	07	2016

6. LER NUMBER

YEAR	SEQUENTIAL NUMBER	REV NO.
2016	001	00

7. REPORT DATE

MONTH	DAY	YEAR
04	06	2016

8. OTHER FACILITIES INVOLVED

FACILITY NAME	DOCKET NUMBER
	05000
FACILITY NAME	DOCKET NUMBER
	05000

9. OPERATING MODE**11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)**

1

<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)
<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)
<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)
<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)

10. POWER LEVEL

088

<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)
<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)
<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input type="checkbox"/> 73.77(a)(1)
<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	<input type="checkbox"/> 73.77(a)(2)(i)
<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(vii)	<input type="checkbox"/> 73.77(a)(2)(ii)
	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> OTHER	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER**LICENSEE CONTACT**

Lee Grzeck, Manager – Regulatory Affairs

TELEPHONE NUMBER (Include Area Code)

(910) 457-2487

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED☐ YES (If yes, complete 15. EXPECTED SUBMISSION DATE) ☒ NO**15. EXPECTED SUBMISSION DATE**

MONTH	DAY	YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On February 7, 2016, at 1312 Eastern Standard Time (EST), Unit 1 was in Mode 1 (i.e., Run) at 88 percent of rated power in end-of-cycle coastdown. At that time, an electrical fault occurred on a balance of plant 4160-volt bus, resulting in a lockout of the Startup Auxiliary Transformer (SAT) and a loss of both Reactor Recirculation pumps. Licensed personnel inserted a manual scram per procedure. Emergency Diesel Generators supplied emergency electrical busses until offsite power was restored at 1628 EST. The loss of power and reactor water level changes resulted in automatic closures of various Primary Containment Isolation Valves (PCIVs). The electrical fault resulted in an electrical explosion; therefore, an Alert was declared at 1326 EDT. The immediate cause of this event was a fault in a non-segregated electrical bus connected to the SAT. The root causes were insufficient detail in applicable maintenance instructions for inspecting the non-segregated bus housing and inadequate instructions for terminating electrical cables in a circuit breaker cubicle. Corrective actions include repairing equipment damaged by the electrical fault and revising the procedures and work instructions.

NRC FORM 366A
(11-2015)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104

EXPIRES: 10/31/2018



LICENSEE EVENT REPORT (LER) CONTINUATION SHEET

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1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
Brunswick Steam Electric Plant (BSEP) Unit 1	05000-325	YEAR	SEQUENTIAL NUMBER	REV NO.
		2016	- 001	- 000

NARRATIVE

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

Background

Initial conditions

On February 7, 2016, at 1312 Eastern Standard Time (EST), Unit 1 was in Mode 1 (i.e., Run) at a power level of 88 percent of rated thermal power in end-of-cycle coastdown. No out-of-service equipment contributed to, or affected the course of, this event.

Reportability Criteria

This event is being reported in accordance with 10 CFR 50.73(a)(2)(iv)(A) because it involved actuations of systems listed in 10 CFR 50.73(a)(2)(iv)(B). Specific actuations included:

- The Reactor Protection System (RPS) [JE] was manually actuated due to loss of both Reactor Recirculation [AD] system pumps.
- Several Primary Containment Isolation Valves (PCIVs) [JM] automatically closed per design in response to either loss of control logic power or reactor water level changes that resulted from the reactor scram.
- Emergency Diesel Generators (EDGs) [EK] started and provided power to emergency electrical busses E1 and E2 [EB] in response to a loss of offsite power (LOOP).
- The High Pressure Coolant Injection (HPCI) [BJ] system was manually started to control reactor pressure following the scram.
- The Reactor Core Isolation Cooling (RCIC) [BN] system was manually started to control reactor water level following the scram.

The NRC was notified of the event, including the emergency declaration, per 10 CFR 50.72(a)(1)(i), 10 CFR 50.72(b)(2)(iv)(B), and 10 CFR 50.72(b)(3)(iv)(A) via Event Notification (EN) number 51715 at 13:46 EST on February 7, 2016.

Event Description

On February 7, 2016, at 1312 EST, BSEP Unit 1 was in Mode 1 during end-of-cycle coastdown. Two arc flashes occurred in a 4160-volt electrical system which resulted in two phases of the system faulting to ground, which also constituted a phase-to-phase fault. The high differential current actuated the lockout on the Unit 1 Startup Auxiliary Transformer (SAT) [EA], which started all four emergency diesel generators. The loss of power to equipment fed from the SAT resulted in shutdown of both Reactor Recirculation system pumps. With both pumps not operating, station procedures require licensed personnel to insert a manual scram. This was performed immediately, and all control rods [AA] fully inserted into the core per design.

The manual scram automatically shut down the main turbine [TA] and main generator [EL] per design. With the main generator offline, the power circuit breakers for the Unit Auxiliary Transformer (UAT) [EA]

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opened per design and deenergized the UAT. This interrupted power to emergency busses E1 and E2. Since the SAT was already locked out, the power source for busses E1 and E2 could not transfer to the SAT. Therefore, a LOOP condition existed on emergency electrical busses E1 and E2. EDG1 and EDG2 were already running and automatically tied to their respective busses, E1 and E2. On Unit 2, EDG3 and EDG4 started per design, but did not connect to their busses because the LOOP condition did not exist on Unit 2.

Following shutdown of the main turbine, reactor pressure was initially controlled by opening safety/relief valves [SB]. When pressure was stable, licensed personnel manually started the HPCI system and maintained control of reactor pressure, and they started the RCIC system for the purpose of maintaining reactor water level. After the manual scram, reactor water level decreased below Low Level 1 per the normal, expected water level shrinkage that follows a reactor scram. The low water level resulted in additional, redundant RPS actuation signals being received, and Group 2 and Group 6 PCIVs received an auto closure signal. The momentary loss of power that occurred between the LOOP and energizing the busses via the EDGs also resulted in Group 1, Group 3, and Group 10 PCIVs receiving a closure signal. All affected PCIVs closed per design.

Standby Gas Treatment System (SBGT) [BH] fans started due to the LOOP condition. However, associated Secondary Containment dampers [VA] did not reposition because the relays in the damper control logic are not designed to seal in, and the duration of the transient when the bus was depowered was too brief for the dampers to physically complete their movement before the EDGs repowered the busses and the signal cleared.

Operations personnel promptly performed a walkdown of plant equipment and noted evidence that an arc flash had occurred in a balance of plant 4160-volt circuit breaker cubicle which supplies the 1B Reactor Recirculation Pump Variable Frequency Drive (VFD) unit. The breaker cubicle showed evidence of an electrical explosion; that is, the cubicle door was deformed. Per Emergency Action Level HA2.1, evidence of an explosion in an area affecting safe shutdown equipment requires entry into an Alert. Thus, the Alert was declared at 1326 EST.

At 1628 EST on February 7, 2016, offsite power was restored to electrical busses E1 and E2 by connecting the UAT to the grid and supplying power to the busses from the UAT, which is their normal source. At 1751 EST, the emergency classification was downgraded to an Unusual Event (UE) because the plant no longer met the criteria for an Alert, since the source of the explosion was determined not to have affected safe shutdown equipment. The UE emergency declaration was terminated at 1814 EST.

Event Causes

The initiating event was two arc flashes that occurred in a non-segregated bus (i.e., a bus in which all three phases lie within a single housing) and in a circuit breaker cubicle which powers the 1B VFD for a Reactor Recirculation system pump. The first arc flash occurred in an area of the bus housing outdoors where water had accumulated. The fault created a voltage imbalance which led to the second arc flash which occurred in the breaker cubicle where cable insulation was found to be degraded.

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Water entered the non-segregated bus housing through a degraded seal and an area that had previously been repaired. The water created the conditions conducive to an arc flash.

In the breaker cubicle for the 1B VFD, it was found that during installation in 2010 of electrical stress-relieving insulation (i.e., "stress cones"), the dielectric insulation on a cable jacket had been damaged when a piece of semiconducting material was being removed. The arc flash occurred at the point where the cable insulation had been damaged.

The root cause of the moisture intrusion into the non-segregated bus was inspection procedures did not contain sufficient specific detail based on highest risk locations (i.e., specifically, horizontal surfaces through which bars penetrate) to ensure that deficiencies that can lead to water intrusion are identified and corrected during its implementation. A contributing cause was that the design of the bus housing is not optimum for the application because it is susceptible to corrosion leading to water intrusion.

The root cause of the damaged cable insulation was failure to specify and use a depth-limiting cutting tool for removing semiconducting material from cable insulation. When workers removed semiconducting material from the cable during initial installation of the cable termination stress cone, the underlying cable dielectric insulation was scored, reducing its insulating effectiveness. This contributed to conditions which led to an arc fault in the affected 4160-volt cable. A contributing cause was lack of a post-installation test method which would be adequate to detect insulation deficiencies.

Safety Assessment

In this event, a LOOP occurred on Unit 1 emergency busses E1 and E2 due to lockout of the SAT and interruption of power to the UAT. The reactor was immediately and safely shut down by manual scram in accordance with station operating procedures. The RCIC system and HPCI system operated as designed and controlled reactor water level and pressure, respectively. All four station EDGs started as expected, and EDGs 1 and 2 supplied power to affected emergency busses E1 and E2. Unit 2 busses E3 and E4 were not affected by the event, and they remained powered by their normal, offsite sources. In addition, the site's supplemental diesel generator was available and could have been used if necessary to mitigate the event. The SAT was not damaged by the event. The UAT remained available for backfeed, and backfeed was implemented per procedure during the event. All safety systems operated per design in response to the event.

Based on the foregoing analysis, it's concluded that this event had no adverse impact on the health and safety of the public.

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Corrective Actions

Any changes to the corrective actions and schedules noted below will be made in accordance with the site's corrective action program.

- Affected equipment related to the event has been repaired, including the affected non-segregated bus housing, conductors and stress cones, and circuit breaker. These actions are completed.
- The procedure for splicing and terminating wires and cables will be revised to include lessons learned from this event, including the use of depth-limiting cutting tools and inspections for damage after cutting operations are performed. This action is expected to be completed by June 30, 2016.
- The procedure and work instructions for inspecting and cleaning the non-segregated busses will be revised to eliminate the root causes of the water intrusion. This action is expected to be completed by August 25, 2016.
- An improved cable testing methodology will be specified in appropriate maintenance procedures. This action is expected to be completed by June 30, 2016.
- The non-segregated bus housing design will be presented for action by the site's Modification Review and Prioritization Team (MRPT) for scheduling and design work. This action is expected to be completed by June 30, 2016.

Previous Similar Events

A review of LERs and the site's corrective action program for the past three years did not identify any previous similar occurrences involving significant electrical faults or LOOP conditions.

Commitments

No regulatory commitments are contained in this report.